CERTAIN MATHEMATICAL IDEALS OF THE JUNIOR HIGH SCHOOL.

The possibility of a new and stimulating course in mathematics in the Junior High School is the most encouraging feature of our recent advance in the teaching of the subject. Such a course enables the schools to break away from the present initial course and prepare the pupil for the best that mathematics has to offer in the high-school period. It enables them to take the best that other countries have to offer and to introduce it by the natural steps that psychology shows that the youth is ready to take. It allows mathematics to relate itself to the interests and apparent needs of young people instead of being presented as a purely abstract science, since the early stages of a rational course can easily be made much more apparently practical than is the case with the present course. The two standard courses in algebra and geometry, as they have come down to us, are satisfactory so far as technique and logic are concerned, and we shall make a great mistake if we lose the best features which they possess. They are not, however, good introductory courses, and we shall do very much better if we can first establish a taste for mathematics, showing numerous applications of the science and various recreations that come along with them, and then offer a set of strong electives in the Senior High School for those who show an aptitude for the subject.

The ideal plan is to give the pupil the best that can be given in each of the school years, so that, if he leaves at the end of any given year, he will have the best all-round view of the subject, up to that point, that we are able to offer. For this reason it is a great error to try to give him only arithmetic in the seventh grade, because this simply reviews what he has already learned in the way of computation. It is much better to give him a broader and more interesting view than this, particularly if in this plan we can include a continued use of arithmetic processes. Similarly, it is a mistake to try to bring

the traditional algebra down into the eighth school year, devoting the whole year to this subject. Such a plan will not give that which is best for the pupil if he leaves at the end of the year. Similarly, it is a mistake to put the business arithmetic all in the ninth year, because, although the pupil has greater maturity for appreciating its significance, if he leaves at the end of the eighth year, as a large number of pupils do, he misses this important subject.

The ideal arrangement would, therefore, seem to be that in the seventh year the pupil shall look at arithmetic from a new angle, considering it with respect to such interests as the home, the store, the most common industries, the simplest features of depositing and withdrawing money at a bank, and the use of computation in connection with mensuration. In this year he should also take up intuitive geometry, which includes the study of the common forms which everyone needs to know, the drawing of such geometric figures as people commonly need to draw, the measurement of such figures, and the locating of points on a map or on some other kind of drawing. In connection with the rules for measuring he will naturally need the formula, and thus he comes to know something of the useful shorthand of algebra and to recognize that it is a practical addition to his mental equipment. If he leaves school at the end of this year, he has now the best that we can give him from the rich field of mathematics, up to the time of his departure. He knows the most common applications of arithmetic, he knows something of graphs, he knows the common geometric forms, he has learned a little algebra in the most natural way possible, and he can use this algebra in his work in measuring simple figures.

In the eighth school year the ideal plan seems to be to carry on the algebra which the pupil has begun, to find the large and practical uses of the subject, and to apply it, where this is reasonable and convenient, to the solving of business problems in arithmetic and to simple measurements. As already said, it is very desirable to put as much arithmetic as possible in this eighth year, so as to meet the needs of that large number of pupils who will leave school at the end of this period. The work of the year may, therefore, well be chiefly the algebra of

the formula, the graph, the negative number, and the simple equation. The arithmetic may well consider those further topics which the average citizen needs to know, neglecting such complicated problems in interest and other topics as he will rarely if ever meet. With such a course we shall again give to the pupil the best that we are able to give, up to the close of the year.

The ninth school year may properly give the pupil a glimpse at a more scientific type of mathematics, for the purpose of trying his powers and tastes, and of letting him see the meaning of that type of mathematics which does large things in the civilization of today. He cannot go far in the field that will be opened before him, but it is our duty to open the gateway and give a glimpse even if we cannot give a vision. The ideal plan seems to be to give to the pupil enough work in the science of algebra to allow him to see what the subject means. This will not be a course in difficult algebraic computation, but a course which will throw light upon the work in arithmetic and will give a range of interesting exercises, illuminating as to the significance of the science. Such a course should take about fifteen weeks. Contrary to earlier practice, trigonometry follows algebra and intuitive geometry more naturally than it follows demonstrative geometry. It may be presented simply, it is interesting to pupils, and it opens an entirely new vista,—that in which the pupil sees the meaning of indirect measurement, the science by the aid of which the engineer calculates distances, the navigator finds his position at sea, and the astronomer explores the heavens. The pupil will not solve such problems as these, but he will solve numerous practical problems of a simpler nature, using the methods upon which the solution of the greater ones rests. Such a glimpse at the meaning of trigonometry will take about a month. The pupil may not remember the details for any considerable length of time, but he will remember the significance of this important branch of mathematical science. The last part of the year, say about ten or fifteen weeks, may properly be given to an introduction to the meaning of a demonstration in geometry. It is not a question of how many propositions the pupil proves, but of having him appreciate the significance of really demonstrating something, of "standing upon the vantage

ground of truth." Many a boy has found his first awakening in mathematics when and only when he has come to the stage of proving a geometric truth, and it is the duty of the schools to give to every pupil this privilege. If the pupil now finds that his mind is not adapted to mathematics, he may properly be advised to try other lines of work. But just as it is our duty to show to every pupil the beauties of good literature, of good music, and of good art, and just as it is his right and privilege to know the great events of history and the great discoveries of science, so it is our duty to show him the significance of elementary mathematics, and it is his right and privilege to know the uses and the beauties of the leading branches of the science.

The attaining of these ideals involves, however, a great responsibility. We shall not reach the goal by any unscientific, scrappy, thoughtless mixing of a little here and a little there taken at random from the conventionally treated parts of inherited mathematics. We shall not reach it by trying to "fuse" demonstrative geometry with the little-related topic of algebra, or by trying to force applications into our demonstrative work when no applications really exist. Such efforts bring all our work into disrepute. We study demonstrative geometry largely for the purpose of knowing what a demonstration means, not for the purpose of learning any considerable number of new facts. It is in the field of intuitive geometry, psychologically reached at a considerably earlier period, that we find the wide range of real applications.

Let us, therefore, attack this great problem with the determination to base our offering upon the teachings of psychology and world experience, with the idea of making our work interesting to the pupil because of its honest applications and its recreational features, and with the knowledge that the rest of the world has made this work a success and that we can do the same. If we do so, there is no reason why, in the course of a few years, we should not have elective courses in the Senior High School that are far ahead of anything that we have at present and of anything that most of us now believe to be possible.

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